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LAKE WINONA, DOUGLAS COUNTY, MINNESOTA

Pacific Northwest Environmental Research Laboratory

Prepared for:

National Environmental Research Center
Minnesota Pollution Control Agency
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December 1974

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U.S. ENVIRONMENTAL PROTECTION AGENCY
NATIONAL EUTROPHICATION SURVEY

WORKING PAPER SERIES

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16. ABSTRACT
Annual total phosphorus and total nitrogen loadings to the lake were estimated and subdivded according to either point or non-point source origin. An assessment of the lake's trophic condition and limiting nutrient is also provided. All data collected by the U.S.E.P.A. National Eutrophication Survey during the one year study of the lake and its tributaries are included in the report.

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REPORT
ON
LAKE WINONA
DOUGLAS COUNTY
MINNESOTA

EPA REGION V

WORKING PAPER No. 135

WITH THE COOPERATION OF THE

MINNESOTA POLLUTION CONTROL AGENCY

AND THE

MINNESOTA NATIONAL GUARD

DECEMBER, 1974

II

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F O R E W O R D

The National Eutrophication Survey was initiated in 1972 in response to an Administration commitment to investigate the nationwide threat of accelerated eutrophication to fresh water lakes and reservoirs.

OBJECTIVES

The Survey was designed to develop, in conjunction with state environmental agencies, information on nutrient sources, concentrations, and impact on selected freshwater lakes as a basis for formulating comprehensive and coordinated national, regional, and state management practices relating to point-source discharge reduction and non-point source pollution abatement in lake watersheds.

ANALYTIC APPROACH

The mathematical and statistical procedures selected for the Survey's eutrophication analysis are based on related concepts that:

a. A generalized representation or model relating sources, concentrations, and impacts can be constructed.

b. By applying measurements of relevant parameters associated with lake degradation, the generalized model can be transformed into an operational representation of a lake, its drainage basin, and related nutrients.

c. With such a transformation, an assessment of the potential for eutrophication control can be made.

LAKE ANALYSIS

In this report, the first stage of evaluation of lake and watershed data collected from the study lake and its drainage basin is documented. The report is formatted to provide state environmental agencies with specific information for basin planning [§303(e)], water quality criteria/standards review [§303(c)], clean lakes [§314(a,b)], and water quality monitoring [§106 and §305(b)] activities mandated by the Federal Water Pollution Control Act Amendments of 1972.

Beyond the single lake analysis, broader based correlations between nutrient concentrations (and loading) and trophic condition are being made to advance the rationale and data base for refinement of nutrient water quality criteria for the Nation's fresh water lakes. Likewise, multivariate evaluations for the relationships between land use, nutrient export, and trophic condition, by lake class or use, are being developed to assist in the formulation of planning guidelines and policies by EPA and to augment plans implementation by the states.

ACKNOWLEDGMENT

The staff of the National Eutrophication Survey (Office of Research & Development, U. S. Environmental Protection Agency) expresses sincere appreciation to the Minnesota Pollution Control Agency for professional involvement and to the Minnesota National Guard for conducting the tributary sampling phase of the Survey.

Grant J. Merritt, Director of the Minnesota Pollution Control Agency, John F. McGuire, Chief, and Joel G. Schilling, Biologist, of the Section of Surface and Groundwater, Division of Water Quality, provided invaluable lake documentation and counsel during the course of the Survey; and the staff of the Section of Municipal Works, Division of Water Quality, were most helpful in identifying point sources and soliciting municipal participation in the Survey.

Major General Chester J. Moeglein, the Adjutant General of Minnesota, and Project Officer Major Adrian Beltrand, who directed the volunteer efforts of the Minnesota National Guardsmen, are also gratefully acknowledged for their assistance to the Survey.

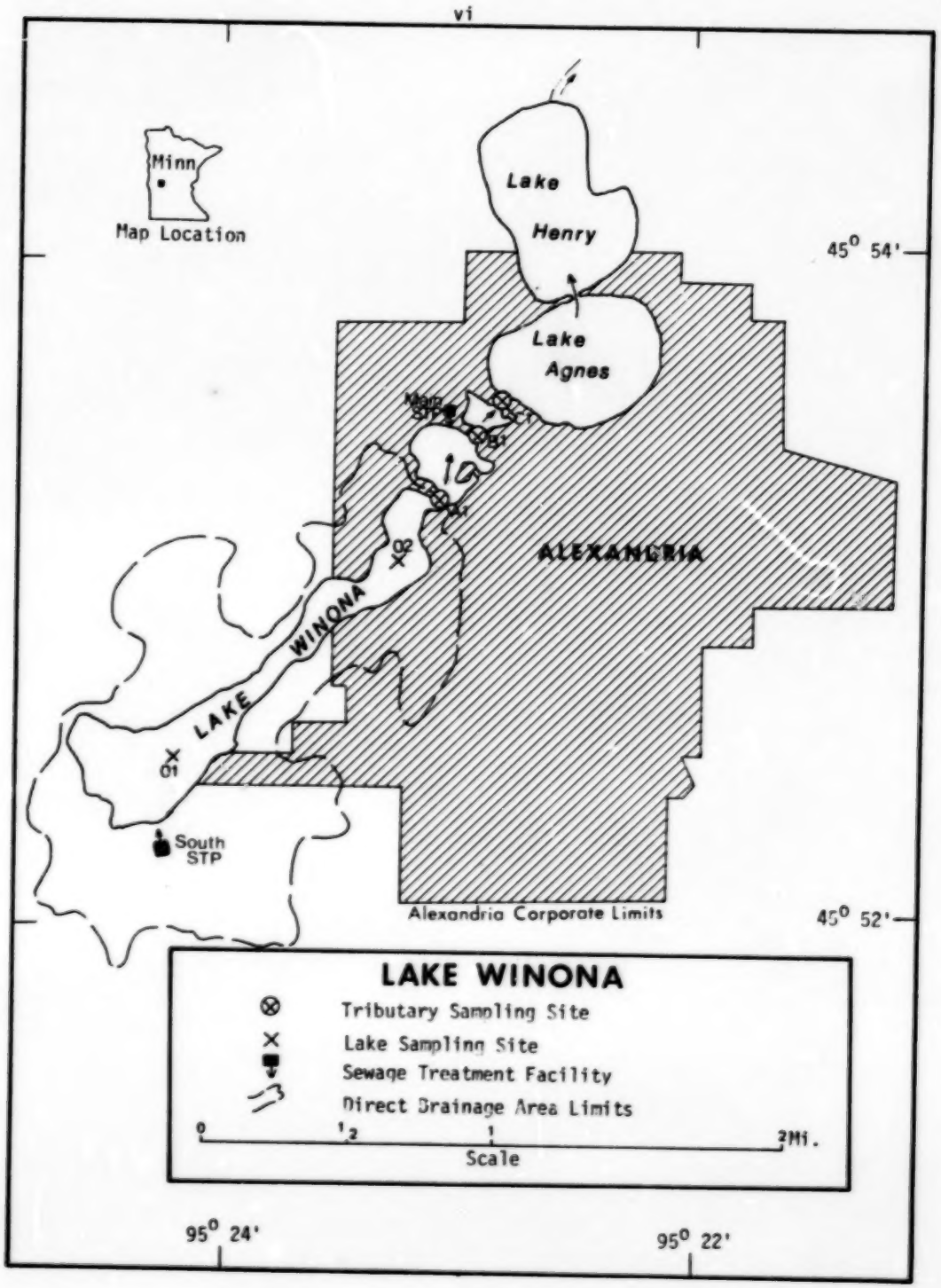
NATIONAL EUTROPHICATION SURVEY

STUDY LAKES

STATE OF MINNESOTA

LAKE NAME	COUNTY
Albert Lea	Freeborn
Andrusia	Beltrami
Badger	Polk
Bartlett	Koochiching
Bear	Freeborn
Bemidji	Beltrami
Big	Stearns
Big Stone	Big Stone, MN; Roberts, Grant, SD
Birch	Cass
Blackduck	Beltrami
Blackhoof	Crow Wing
Budd	Martin
Buffalo	Wright
Calhoun	Hennepin
Carlos	Douglas
Carrigan	Wright
Cass	Beltrami, Cass
Clearwater	Wright, Stearns
Cokato	Wright
Cranberry	Crow Wing
Darling	Douglas
Elbow	St. Louis
Embarass	St. Louis
Fall	Lake
Forest	Washington
Green	Kandiyohi
Gull	Cass
Heron	Jackson
Leech	Cass
Le Homme Dieu	Douglas
Lily	Blue Earth
Little	Grant
Lost	St. Louis

LAKE NAME	COUNTY
Madison	Blue Earth
Malmedal	Pope
Mashkenode	St. Louis
McQuade	St. Louis
Minnetonka	Hennepin
Minnewaska	Pope
Mud	Itasca
Nest	Kandiyohi
Pelican	St. Louis
Pepin	Goodhue, Wabasha, MN; Pierce, Pepin, WI
Rabbit	Crow Wing
Sakatah	Le Sueur
Shagawa	St. Louis
Silver	McLeod
Six Mile	St. Louis
Spring	Washington, Dakota
St. Croix	Washington, MN; St. Croix, Pierce, WI
St. Louis Bay	St. Louis, MN; Douglas, WI
Superior Bay	St. Louis, MN; Douglas, WI
Swan	Itasca
Trace	Todd
Trout	Itasca
Wagonga	Kandiyohi
Wallmark	Chisago
White Bear	Washington
Winona	Douglas
Wolf	Beltrami, Hubbard
Woodcock	Kandiyohi
Zumbro	Olmstead, Wabasha


Minn
Map Location
Lake
Henry
Lake
Agnes
45° 54'
ALEXANDRIA
LAKE WINONA
01
02
South
STP
Alexandria Corporate Limits
45° 52'
LAKE WINONA
Tributary Sampling Site
Lake Sampling Site
Sewage Treatment Facility
Direct Drainage Area Limits
0
1/2
1
2Mi.
Scale
95° 24'
95° 22'

LAKE WINONA

STORET NO. 27A1

I. CONCLUSIONS

A. Trophic Condition:

Survey data show that Lake Winona is eutrophic. Of the 60 Minnesota lakes sampled in the fall, 39 had less mean total phosphorus, 18 had less mean dissolved phosphorus, and 33 had less mean inorganic nitrogen. Of the 80 lakes sampled, 59 had less mean chlorophyll a, and 58 had greater Secchi disc transparency.

A Minnesota Pollution Control Agency report notes the October, 1967, occurrence of "very large concentrations of planktonic algae" in Lake Winona (Bishop and McGuire, 1968).

B. Rate-Limiting Nutrient:

The results of the algal assay show that the lake was nitrogen limited at the time the sample was collected (May 1, 1973; see page 8).

Lake data indicate nitrogen limitation in July and late August, 1972 (N/P ratios were 11/1 or less), but a borderline N/P ratio of 14/1 in October.

C. Nutrient Controllability:

During the sampling year, Lake Winona received a total phosphorus load at a rate about eight times that proposed by

Vollenweider (in press) as "dangerous"; i.e., a eutrophic rate (see page 14). Of this load, the Alexandria South plant is estimated to have contributed about 97% (the Alexandria Main plant discharges to Upper Lake Winona "downstream" from Lake Winona).

At present, the Alexandria Lakes Sanitary District, formed in 1970 (includes the City of Alexandria and the townships of Alexandria, Carlos, Hudson, and LeGrand), is expanding the South plant to accomodate all of the sewage of the City of Alexandria and the District with effluent discharge to Lake Winona. Chemical phosphorus removal will be provided, and the effluent will be limited to a mean of 1.0 mg/l P.

On the basis of the flows measured during the sampling year at the Alexandria Main plant and the South plant (total of 0.924 mgd), and the effluent limit of 1.0 mg/l P, it is calculated that the expanded South plant will discharge about 2,800 lbs/P/yr to Lake Winona. This will <u>increase</u> the loading rate from the existing 1.65 $g/m^2/yr$ to 1.69 $g/m^2/yr$. While the removal of the Main plant discharge to Upper Lake Winona should reduce nuisance conditions in lakes Agnes and Henry, as well as provide additional protection for the downstream lakes Le Homme Dieu and Carlos, the resulting increased loading to Lake Winona will doubtless worsen an already poor trophic condition. Moreover, when the design flow

of the new plant is reached (2.0 mgd; Schilling, 1974), the loading rate to the lake will be increased to 2.60 $g/m^2/yr$ or 18 times the eutrophic rate!

If the trophic condition of Lake Winona is not to be further degraded, it is concluded that it will be necessary to eliminate the effluent discharge of the expanded waste treatment plant by diversion or by land disposal.

II. LAKE AND DRAINAGE BASIN CHARACTERISTICS

A. Lake Morphometry†:

1. Surface area: 192 acres.
2. Mean depth: 44 feet.
3. Maximum depth: 8 feet.
4. Volume: 845 acre/feet.
5. Mean hydraulic retention time: 1.5 years††.

B. Tributary and Outlet:
(See Appendix A for flow data)

1. Tributaries -

Name	Drainage area*	Mean flow*
(None)	-	-
Minor tributaries & immediate drainage -	2.6 mi^2	0.4 cfs
Totals	2.6 mi^2	0.4 cfs

2. Outlet -

Upper Lake Winona inlet	2.9 mi^2**	0.4 cfs

C. Precipitation***:

1. Year of sampling: 22.9 inches.
2. Mean annual: 22.6 inches.

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† DNR field map (1966); mean depth by random-dot method.
†† Alexandria South plant flow of 0.4 cfs included in calculation.
* Drainage areas are accurate within ±5%; mean daily flows are accurate within ±10%; and ungaged flows are accurate within ±10 to 25% for drainage areas greater than 10 mi^2.
** Includes area of lake.
*** See Working Paper No. 1, "Survey Methods".

III. LAKE WATER QUALITY SUMMARY

Lake Winona was sampled three times during the open-water season of 1972 by means of a pontoon-equipped Huey helicopter. Each time, samples for physical and chemical parameters were collected from two stations on the lake and from two or more depths at each station (see map, page vi). During each visit, a single depth-integrated (near bottom to surface) sample was composited from the two stations for phytoplankton identification and enumeration; and during the last visit, a single five-gallon depth-integrated sample was composited for algal assays. Also each time, a single depth-integrated sample was collected from each of the stations for chlorophyll a analysis. The maximum depths sampled were 9 feet at station 1 and 6 feet at station 2.

The results obtained are presented in full in Appendix B, and the data for the fall sampling period, when the lake essentially was well-mixed, are summarized below. Note, however, the Secchi disc summary is based on all values.

For differences in the various parameters at the other sampling times, refer to Appendix B.

A. Physical and chemical characteristics:

Parameter	Minimum	Mean	Median	Maximum
		FALL VALUES (10/28/72)		
Temperature	4.9	4.9	4.9	4.9
Dissolved oxygen (mg/l)	11.2	11.6	11.6	12.0
Conductivity (μmhos)	380	395	390	420
pH (units)	8.3	8.3	8.3	8.4
Alkalinity (mg/l)	156	159	159	164
Total P (mg/l)	0.103	0.112	0.110	0.126
Dissolved P (mg/l)	0.020	0.020	0.020	0.021
$NO_2 + NO_3$ (mg/l)	0.100	0.140	0.140	0.180
Ammonia (mg/l)	0.130	0.145	0.145	0.160
		ALL VALUES		
Secchi disc (inches)	16	21	21	24

B. Biological characteristics:

1. Phytoplankton -

Sampling Date	Dominant Genera	Number per ml
07/06/72	1. Lyngbya	54,545
	2. Marssoniella	10,182
	3. Flagellates	3,818
	4. Merismopedia	3,091
	5. Chroococcus	182
	Other genera	14,364
	Total	86,182
09/01/72	1. Lyngbya	103,571
	2. Microcystis	24,286
	3. Anabaena	10,714
	4. Merismopedia	6,428
	5. Scenedesmus	3,571
	Other genera	10,001
	Total	158,571
10/28/72	1. Oscillatoria	30,758
	2. Lyngbya	21,364
	3. Flagellates	9,545
	4. Microcystis	8,485
	5. Synedra	6,667
	Other genera	18,333
	Total	95,152

2. Chlorophyll a -
(Because of instrumentation problems during the 1972 sampling, the following values may be in error by plus or minus 20 percent.)

Sampling Date	Station Number	Chlorophyll a (µg/l)
07/06/72	01	20.8
	02	14.9
09/01/72	01	71.9
	02	77.8
10/28/72	01	88.7
	02	77.2

C. Limiting Nutrient Study:
(The algal assay sample collected in October, 1972, was lost in transit, and Minnesota Pollution Control Agency personnel resampled the lake in early May of 1973. Therefore, the results given here may not be related directly to Survey lake data, although the chemical analyses of the raw 1973 sample are quite similar.)

1. Autoclaved, filtered, and nutrient spiked -

Spike (mg/l)	Ortho P Conc. (mg/l)	Inorganic N Conc. (mg/l)	Maximum yield (mg/l-dry wt.)
Control	0.037	0.380	21.6
0.010 P	0.047	0.380	21.1
0.020 P	0.057	0.380	22.5
0.050 P	0.087	0.380	20.3
0.050 P + 5.0 N	0.087	5.380	65.5
0.050 P + 10.0 N	0.087	10.380	60.6
10.0 N	0.037	10.380	51.7

2. Discussion -

The control yield of the assay alga, Selenastrum capricornutum, indicates that the potential primary productivity of Lake Winona was quite high at the time the sample was collected (05/01/73). The results also show that the lake

was nitrogen limited. Note the lack of significant change in yields with increased levels of orthophosphorus until nitrogen was also added, and that the addition of only nitrogen resulted in a yield much greater than the control yield.

During the sampling year, the lake data indicate nitrogen limitation in July (N/P ratio = 6/1), nitrogen limitation in September (N/P ratio = 11/1), but a borderline N/P ratio of 14/1 in October (phosphorus could have been limiting).

IV. NUTRIENT LOADINGS
(See Appendix C for all data)

For the determination of nutrient loadings, the Minnesota National Guard collected monthly near-surface grab samples from each of the tributary sites indicated on the map (page vi), except for the high runoff months of April and May when two samples were collected. Sampling was begun in October, 1972, and was completed in September, 1973.

Through an interagency agreement, stream flow estimates for the year of sampling and a "normalized" or average year were provided by the Minnesota District Office of the U.S. Geological Survey for the tributary sites nearest the lake.

In this report, nutrient loads for sampled tributaries were determined by using a modification of a U.S. Geological Survey computer program for calculating stream loadings*. Nutrient loadings for "minor tributaries and immediate drainage" ("ZZ" of U.S.G.S.) were estimated by using the nutrient loads, in lbs/mi^2/year, in Krueger's Slough outlet at station 27B5B-1, and multiplying by the ZZ area in mi^2.

The operator of the Alexandria South wastewater treatment plant provided monthly effluent samples and corresponding flow data (the Alexandria Main plant discharges to Upper Lake Winona).

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* See Working Paper No. 1.

A. Waste Sources:

1. Known municipal† -

Name	Pop. Served	Treatment	Mean Flow (mgd)	Receiving Water
Alexandria South	1,883*	act. sludge	0.260	Swamp to Lake Winona

2. Known industrial - None

† Anonymous, 1974.
* Estimated 27% of Alexandria population served by this plant.

B. Annual Total Phosphorus Loading - Average Year:

1. Inputs -

Source	lbs P/ yr	% of total
a. Tributaries (non-point load) -		
(None)	-	-
b. Minor tributaries & immediate drainage (non-point load) -	30	1.1
c. Known municipal STP's -		
Alexandria South	2,750	97.2
d. Septic tanks* -	20	0.6
e. Known industrial - None	-	-
f. Direct precipitation** -	30	1.1
Total	2,830	100.0

2. Outputs -

Lake outlet - Upper Lake Winona inlet 120

3. Net annual P accumulation - 2,710 pounds

* Estimate based on 35 lakeshore dwellings; see Working Paper No. 1.
** See Working Paper No. 1.

C. Annual Total Nitrogen Loading - Average Year

1. Inputs -

Source	lbs N/yr	% of total
a. Tributaries (non-point load) -		
(None)	-	-
b. Minor tributaries & immediate drainage (non-point load) -	980	7.8
c. Known municipal STP's -		
Alexandria South	8,850	70.8
d. Septic tanks* -	820	6.6
e. Known industrial - None	-	-
f. Direct precipitation** -	1,850	14.8
Total	12,500	100.0

2. Outputs -

Lake outlet - Upper Lake Winona inlet	1,800

3. Net annual N accumulation - 10,700 pounds

* Estimate based on 35 lakeshore dwellings; see Working Paper No. 1.
** See Working Paper No. 1.

D. Yearly Loading Rates:

In the following table, the existing phosphorus loading rates are compared to those proposed by Vollenweider (in press). Essentially, his "dangerous" rate is the rate at which the receiving waters would become eutrophic or remain eutrophic; his "permissible" rate is that which would result in the receiving water remaining oligotrophic or becoming oligotrophic if morphometry permitted. A mesotrophic rate would be considered one between "dangerous" and "permissible".

	Total Phosphorus		Total Nitrogen	
Units	Total	Accumulated	Total	Accumulated
lbs/acre/yr	14.7	14.1	65.1	55.7
grams/m^2/yr	1.65	1.58	7.3	6.2

Vollenweider loading rates for phosphorus ($g/m^2/yr$) based on mean depth and mean hydraulic retention time of Lake Winona:

"Dangerous" (eutrophic rate)	0.20
"Permissible" (oligotrophic rate)	0.10

V. LITERATURE REVIEWED

Anonymous, 1969. Report on water quality investigation of the Long Prairie River and lakes Carlos, Le Homme Dieu and Osakis. MPCA, Minneapolis.

Anonymous, 1974. Wastewater disposal facilities inventory. MPCA, Minneapolis.

Bishop, Kyle M., and John F. McGuire, 1968. Report on pollution of lakes Winona, Agnes, and Henry. MPCA, Minneapolis.

Schilling, Joel, 1974. Personal communication (lake map; treatment requirements at Alexandria). MPCA, Minneapolis.

Vollenweider, Richard A. (in press). Input-output models. Schweiz. A. Hydrol.

TRIBUTARY FLOW INFORMATION FOR MINNESOTA 10/30/74

LAKE CODE 2781 [illegible]

TOTAL DRAINAGE AREA OF LAKE = 3.14

TRIBUTARY	SUBDRAINAGE AREA	NORMALIZED FLOWS JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	MEAN
27A1A1	2.44	[illegible]	[illegible]	[illegible]	0.98	0.72	0.47	0.44	0.23	0.19	0.31	0.21	0.07	0.37
27A1H1	1.03	[illegible]	[illegible]	[illegible]	1.19	0.76	1.13	0.52	0.24	0.20	0.31	0.21	0.08	0.41
27A1C1	3.14	[illegible]	[illegible]	1.31	1.25	0.79	1.18	0.53	0.24	0.21	0.33	0.21	0.08	0.42
27A1Z7	2.44	[illegible]	[illegible]	1.35	1.11	0.73	0.46	0.49	0.24	0.20	0.31	0.21	0.08	0.40

SUMMARY

TOTAL DRAINAGE AREA OF LAKE = 3.14
SUM OF SUBDRAINAGE AREAS = 8.73
TOTAL FLOW IN = 14.06
TOTAL FLOW OUT = 5.07

NOTE 002 21 AREA A DISCHARGES ARE INCLUDED IN M11 M1 DATA IS INCLUDED IN C1

MEAN MONTHLY FLOWS AND DAILY FLOWS

TRIBUTARY	MONTH	YEAR	MEAN FLOW	DAY	FLOW	DAY	FLOW	DAY	FLOW
27A1A1	10	73	0.56	14	0.90				
	11	73	0.43	15	0.60				
	12	73	0.30	15	0.30				
	1	74	0.11	12	0.11				
	2	74	0.11	21	0.11				
	3	74	1.31	13	1.10				
	4	74	0.91	5	1.10	19	0.80		
	5	74	0.74	3	1.10	17	0.60		
	6	74	0.48	2	0.60				
	7	74	0.58	11	0.58				
	8	74	0.44	23	0.34				
	9	74	0.31	18	0.24				
27A1H1	10	73	[illegible]	14	0.90				
	11	73	0.43	15	0.60				
	12	73	[illegible]	15	0.30				
	1	74	[illegible]						
	2	74	[illegible]	21	0.11				
	3	74	[illegible]	13	[illegible]				
	4	74	[illegible]	5	[illegible]	19	0.90		
	5	74	[illegible]	3	[illegible]	17	0.60		
	6	74	[illegible]	2	[illegible]				
	7	74	[illegible]	11	[illegible]				
	8	74	[illegible]	23	[illegible]				
	9	74	[illegible]	18	[illegible]				

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TRIBUTARY FLOW INFORMATION FOR MINNESOTA 10/30/74

LAKE CODE 27A1 WINONA LAKE

MEAN MONTHLY FLOWS AND DAILY FLOWS

TRIBUTARY	MONTH	YEAR	MEAN FLOW	DAY	FLOW	DAY	FLOW	DAY	FLOW
27A1C1	10	72	0.90	14	1.00				
	11	72	0.63	15	0.60				
	12	72	0.34	15	0.30				
	1	73	0.10						
	2	73	0.11	21	0.10				
	3	73	1.40	31	1.20				
	4	73	1.00	5	1.20	19	0.90		
	5	73	0.87	3	1.20	17	0.70		
	6	73	0.52	8	0.70				
	7	73	0.64	11	0.62				
	8	73	0.46	23	0.40				
	9	73	0.33	18	0.27				
27A1ZZ	10	72	0.84	14	0.90				
	11	72	0.63	15	0.60				
	12	72	0.34	15	0.30				
	1	73	0.15	12	0.10				
	2	73	0.27	21	0.30				
	3	73	1.58	13	1.30				
	4	73	0.90	5	1.10	19	0.80		
	5	73	0.80	3	1.10	17	0.60		
	6	73	0.47	8	0.60				
	7	73	0.59	11	0.58				
	8	73	0.46	23	0.40				
	9	73	0.31	18	0.26				

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APPENDIX B

PHYSICAL and CHEMICAL DATA

STORET RETRIEVAL DATE 74/10/30

27A101
45 52 30.0 095 24 12.0
WINONA LAKE
27105 MINNESOTA

11EPALES 2111202
3 0010 FEET DEPTH

DATE FROM TO	TIME OF DAY	DEPTH FEET	00010 WATER TEMP CENT	00300 DO MG/L	00077 TRANSP SECCHI INCHES	00094 CNDUCTVY FIELD MICROMHO	00400 PH SU	00410 T ALK CACO3 MG/L	00630 NO2&NO3 N-TOTAL MG/L	00610 NH3-N TOTAL MG/L	00665 PHOS-TOT MG/L P	00666 PHOS-DIS MG/L P
72/07/06	10	18 0000	20.0		24	340	8.30	139	0.080	0.060	0.058	0.019
	10	18 0004	20.1	15.4		340	8.30	139	0.080	0.060	0.079	0.034
	10	18 0009	13.9	7.6		345	8.30	138	0.070	0.050	0.059	0.021
72/09/01	15	30 0000	19.7		22	420	8.40	132	0.130	0.180	0.109	0.031
	15	30 0004	19.8	8.8		375	8.45	132	0.170	0.190	0.106	0.030
72/10/28	08	55 0000			19	420	8.30	164	0.180	0.160	0.103	0.020
	08	55 0004	4.9	11.2		400	8.30	160	0.160	0.160	0.126	0.020

DATE FROM TO	TIME OF DAY	DEPTH FEET	32217 CHLRPHYL A UG/L
72/07/06	10	18 0000	20.4J
72/09/01	15	30 0000	71.9J
72/10/28	08	55 0000	88.7J

J VALUE KNOWN TO BE IN ERROR

20

STORET RETRIEVAL DATE 74/10/30

27A102
45 53 07.0 095 23 14.0
WINONA LAKE
27 MINNESOTA

11EPALES
3

2111202
0007 FEET DEPTH

DATE FROM TO	TIME OF DAY	DEPTH FEET	00010 WATER TEMP CENT	00300 DO MG/L	00077 TRANSP SECCHI INCHES	00094 CNDUCTVY FIELD MICROMHO	00400 PH SU	00410 T ALK CACO3 MG/L	00630 NO2&NO3 N-TOTAL MG/L	00610 NH3-N TOTAL MG/L	00665 PHOS-TOT MG/L P	00666 PHOS-DIS MG/L P
72/07/06	10 45	0000	20.1		24	330	8.40	129	0.050	0.050	0.070	0.022
	10 45	0004	20.1	8.4		330	8.40	135	0.060	0.060	0.117	0.022
	10 45	0006	20.1	9.8		330	8.40	140	0.110	0.100	0.104	0.024
72/09/01	15 45	0000	20.4		20	340	8.65	118	0.170	0.200	0.110	0.037
	15 45	0004	20.0	8.4		340	8.50	119	0.160	0.210	0.109	0.033
72/10/28	09 15	0000			16	380	8.40	157	0.120	0.130	0.108	0.020
	09 15	0004	4.9	12.0		380	8.40	156	0.100	0.130	0.112	0.021

DATE FROM TO	TIME OF DAY	DEPTH FEET	32217 CHLRPHYL A UG/L
72/07/06	10 45	0000	14.9J
72/09/01	15 45	0000	77.8J
72/10/28	09 15	0000	77.2J

J VALUE KNOWN TO BE IN ERROR

APPENDIX C

TRIBUTARY and WASTEWATER TREATMENT PLANT DATA

STORET RETRIEVAL DATE 74/10/30

27A1A1 LS27A1A1
45 53 30.0 095 23 00.0
CON LK WINONA & 1ST LK TO NW
27105 7.5 ALEXANDRIA W
T/LAKE WINONA
AT BRDG W ALEXANDRIA 5TH AVE.
11EPALES 2111204
4 0000 FEET DEPTH

DATE FROM TO	TIME OF DAY	DEPTH FEET	00630 NO2&NO3 N-TOTAL MG/L	00625 TOT KJEL N MG/L	00610 NH3-N TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P	00665 PHOS-TOT MG/L P
72/10/14	09 00		0.130	2.250	0.160	0.028	0.148
72/11/15	13 15		0.078	1.800	0.075	0.033	0.110
72/12/15	09 30		0.042	2.200	0.410	0.017	0.096
73/01/12	13 40		0.014	2.900	1.400	0.026	0.200
73/02/21	09 30		0.010K	3.400	2.000	0.029	0.165
73/03/13	13 25		0.168	2.200	1.045	0.108	0.250
73/04/05	13 10		0.092	3.600	0.380	0.015	0.135
73/04/19	12 30		0.016	1.600	0.017	0.036	0.140
73/05/03	13 05		0.014	2.000	0.017	0.042	0.150
73/05/17	13 15		0.010K	2.100	0.006	0.038	0.160
73/06/08	09 40		0.290	2.200	0.056	0.006	0.115
73/07/11	13 00		0.027	3.000	0.063	0.028	0.155
73/08/23			0.019	2.300	0.019	0.064	0.260
73/09/18	13 00		0.032	2.600	0.038	0.200	0.200

K: VALUE KNOWN TO BE LESS THAN INDICATED

STORET RETRIEVAL DATE 74/10/30

27A181 LS27A181
45 53 30.0 095 23 00.0
CON BETW LAKES WINONA & AGNES
27 7.5 ALEXANDRIA W
T/LAKE WINONA
US 52 BRDG NW ALEXANDRIA
11EPALES 2111204
4 0000 FEET DEPTH

DATE FROM TO	TIME OF DAY	DEPTH FEET	00630 NO2&NO3 N-TOTAL MG/L	00625 TOT KJEL N MG/L	00610 NH3-N TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P	00665 PHOS-TOT MG/L P
72/10/14	09 05		0.085	3.250	0.168	0.066	0.310
72/11/15	13 25		0.110	2.000	0.560	0.042	0.170
72/12/15	09 30		0.027	2.400	0.650	0.025	0.189
73/01/12	13 45		0.014	2.900	1.260	0.054	0.240
73/02/21	09 40		0.010K	3.570	1.790	0.079	0.280
73/03/13	13 30		0.120	2.310	0.790	0.054	0.185
73/04/05	13 30		0.010K	3.300	0.027	0.032	0.220
73/04/19	12 40		0.012	3.700	0.050	0.075	0.270
73/05/03	13 10		0.010K	2.275	0.017	0.096	0.315
73/05/17	13 20		0.016	2.250	0.005K	0.096	0.280
73/06/08	09 45		0.610	1.680	0.088	0.006	0.170
73/07/11	13 05		0.044	1.760	0.087	0.027	0.150
73/08/23			0.056	3.300	0.060	0.154	0.410

K VALUE KNOWN TO BE LESS THAN INDICATED

24

STORET RETRIEVAL DATE 74/10/30

27A1C1 LS27A1C1
45 53 30.0 095 22 30.0
CON BETW LK AGNES & 1ST LK SW
27 7.5 ALEXANDRIA W
T/LAKE WINONA
HWY BRDG 1 MI NW ALEXANDRIABROADWAY ST.
11EPALES 2111204
4 0000 FEET DEPTH

DATE FROM TO	TIME OF DAY	DEPTH FEET	00630 NO2&NO3 N-TOTAL MG/L	00625 TOT KJEL N MG/L	00610 NH3-N TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P	00665 PHOS-TOT MG/L P
72/10/14	09 10		0.880	8.700	0.740	0.560	0.810
72/11/15	14 00		1.050	4.200	2.300	2.600	2.880
72/12/15	10 00		1.840	7.200	4.800	3.100	3.300
73/01/12	13 50		1.760	9.600	5.900	3.400	3.600
73/02/21	09 45		1.100	11.000	6.000	3.300	3.700
73/03/13	13 30		0.790	8.800	4.900	2.300	2.630
73/04/05	13 20		1.420		3.950	2.200	2.600
73/04/19	12 50		2.500	5.200	0.850	2.000	2.500
73/05/03	13 15		2.800	5.300	0.770	1.900	2.300
73/05/17	13 25		2.100	6.200	0.060	0.950	2.200
73/06/08	09 50		0.510	7.600	0.180	0.005K	3.300
73/07/11	13 10		1.120	9.200	0.255	0.790	2.630
73/08/23			2.000	0.990	0.470	1.890	3.100
73/09/18	13 15		3.500	7.850	0.190	2.100	4.000

K VALUE KNOWN TO BE LESS THAN INDICATED

25

STORET RETRIEVAL DATE 74/10/30

27A151 AS27A151 P002500
45 53 30.0 095 23 00.0
ALEXANDRIA
27105 7.5 W ALEXANDRIA
D/WINONA LAKE
LAKE WINONA
11EPALES 2141204
4 0000 FEET DEPTH

DATE FROM TO	TIME OF DAY	DEPTH FEET	00630 NO2&NO3 N-TOTAL MG/L	00625 TOT KJEL N MG/L	00610 NH3-N TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P	00665 PHOS-TOT MG/L P	50051 FLOW RATE INST MGD	50053 CONDUIT FLOW-MGD MONTHLY
73/02/01	10 00								
CP(T)-			11.200	3.900	0.410	3.500	3.700	0.280	0.257
73/02/01	15 00								
73/03/01	10 00								
CP(T)-			4.200	23.000	6.900	7.200	8.200	0.270	0.250
73/03/01	15 00								
73/04/01	10 00								
CP(T)-			9.700	3.125	0.060	3.800	4.000	0.270	0.292
73/04/01	15 00								
73/05/01	10 00								
CP(T)-			6.100	5.100	0.170	2.450	2.900	0.290	0.277
73/05/01	15 00								
73/06/04	10 00								
CP(T)-			4.200	2.700	0.160	1.000	1.000	0.250	0.294
73/06/04	15 00								
73/08/01	10 00								
CP(T)-			0.100	5.500	0.130	0.960	1.500	0.230	0.247
73/08/01	15 00								
73/09/04	10 30		0.013	2.870		1.060		0.280	0.252
73/10/01	10 00								
CP(T)-			0.050	4.900	0.055	1.050	1.400	0.210	0.245
73/10/01	15 00								
73/11/08	10 00								
CP(T)-			0.699	1.700	0.083	1.980	2.000	0.210	0.245
73/11/08	15 00								
73/12/07	10 00								
CP(T)-			0.240	3.800	0.098	3.360	3.512	0.250	0.235
73/12/07	14 00								
74/01/04	10 00								
CP(T)-			9.100	5.400	0.100	4.500	4.900	0.310	0.266
74/01/04	14 00								
74/02/07	10 00								
CP(T)-			13.400	8.600	0.120	2.800	5.250	0.260	0.266
74/02/07	14 00								